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Extreme Mortality Bonds

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IAA Life Colloquium, Munich 2009

September 9, 2009

Agenda

- Transaction Objectives
- Financial Structure
- Mechanism Overview
- Underlying Risk
- Pandemic Modeling
- EMB Pricing
- 2009 influenza A/H1N1

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Transaction Objectives

For issuers

- Protection against extreme mortality risk
  - Systemic risk
  - Exclusion from traditional reinsurance
  - Cover duration

For Investors

- New class of securities
  - Higher spreads
  - Non-correlation

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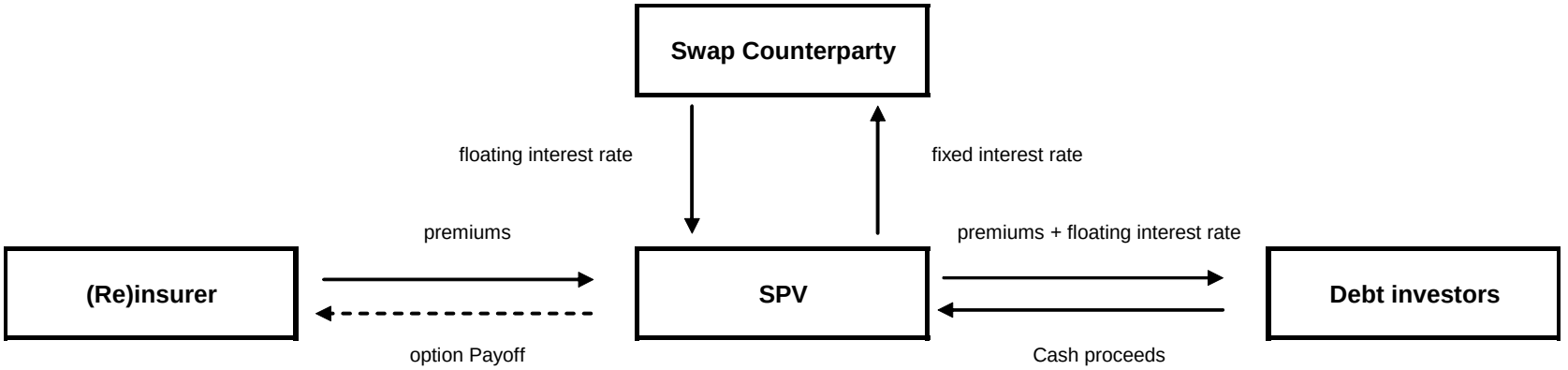
Financial Structure



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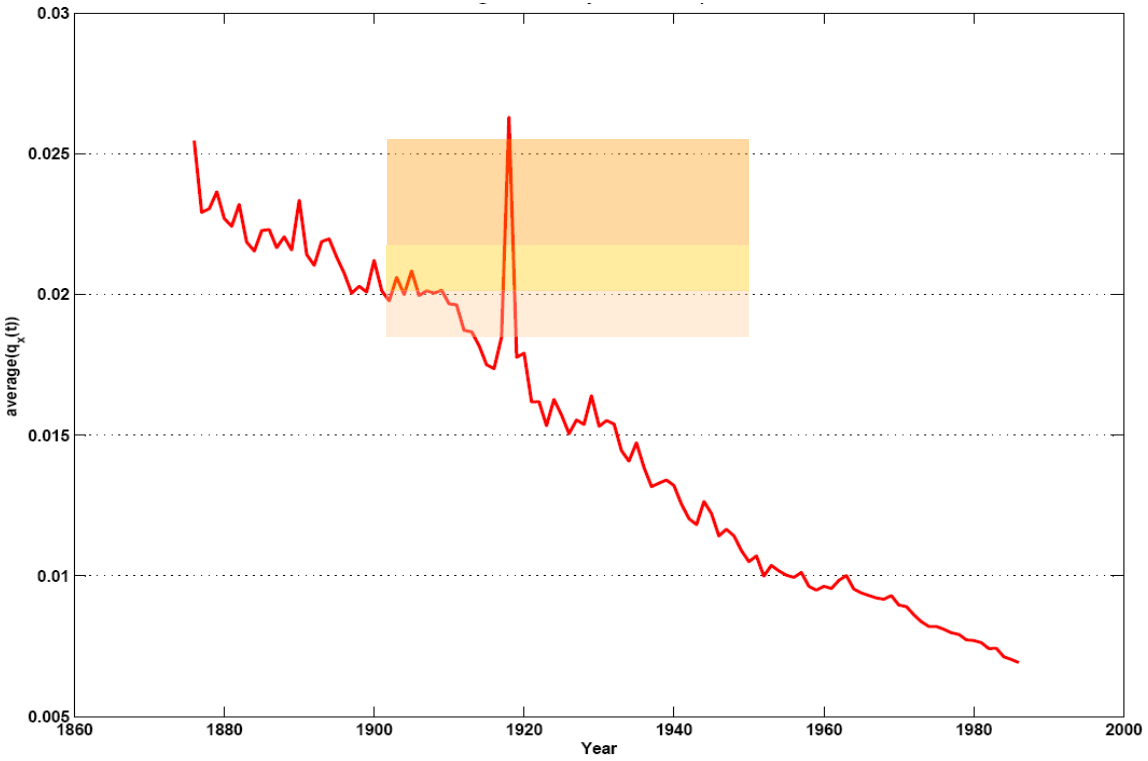
Mechanism Overview

Mortality Index

- Based on age and gender weighted death rates
- Based on national index(es) of mortality



	VITA III
Sponsor	Swiss Re
Year	2006
Mortality Index	62.5% United States 17.5% United Kingdom 7.5% Germany 7.5% Japan 5% Canada
Risk Period	4 and 5 years
Index Calculation	2-year average
Trigger / Exhaustion Levels (% of Base Index)	A: 125% / 145% B: 120% / 125% C: 115% / 120% D: 110% / 115%

Source: Swiss Re

Mechanism Overview

Reduction in outstanding Principal of the Bond

- Index < Attachment point → Principal repayable in Full
- Index > Exhaustion point → Principal completely exhausted
- Linear Reduction between Attachment point and Exhaustion point

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Mechanism Overview

n the duration of the bond and $m = n - 1$ the number of measurement periods

I_t the value of the mortality index measured at time $t = 2...m$

A the attachment point

E the exhaustion point

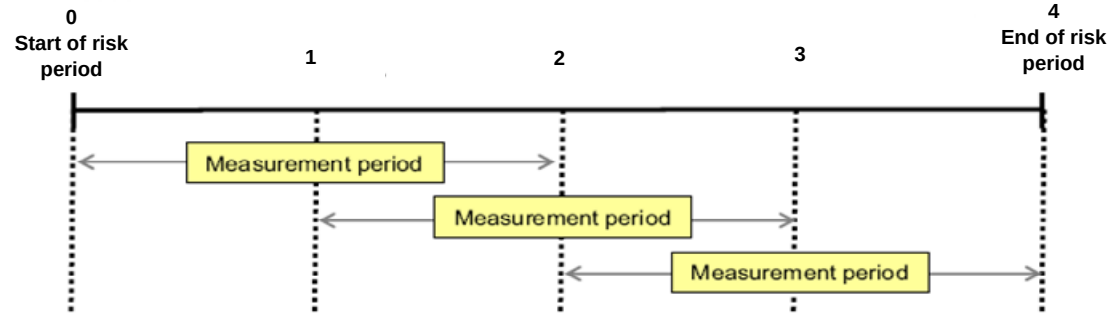
At the end of the measurement period $t = 2...m$, the reduction in principal is:

$$R_t = \max\left(\frac{I_t - A}{E - A} - R_{t-1}; 0\right) \qquad (R_1 = 0)$$

With the constraint that the cumulative principal reduction cannot exceed 100%:

$$\sum_{i=2}^{t} R_i \leq 100\%$$

At time t, the outstanding capital is equal to: $100\% - \sum^{t} R_i$



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Mechanism Overview

Life Catastrophe Excess of Loss vs. EMB

- EMB Structure close to a stop loss cover
- Indemnity vs. parametric (ie basis risk for EMB)
- Duration
- Pandemics completely excluded from Life Cat XL

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Underlying Risk

Events

- Pandemic disease
- Terrorism event
- Natural disaster
- Heat wave
- Industrial accident
- Conventional/Nuclear war

Risk profile

- Index based (parametric and not indemnity)
- Low frequency
- High severity

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Underlying Risk

An Epidemic is a disease that appears as new cases in a given human population, during a given period, at a rate that substantially exceeds what is “expected”, based on recent experience.

A Pandemic is an epidemic that spreads worldwide, or at least across a large region.

Underlying Risk

31 pandemics since 1580 (according to the WHO)

Year	Name	Deaths	Lethality rate
1918-1919	Spanish flu	~ 50 million	~ 10%
1957-1958	Asian flu	~ 2 million	~ 0,37% (US)
1968-1969	Hong Kong flu	~ 1 million	~ 0,19% (US)
1977	Russian flu	10 000 in US	?
2003	SARS	299 in HK	up to 71% in HK

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Pandemic Modeling

Approach: Frequency * Severity

- **Frequency: 7.4%** per annum based on **31 influenza** epidemics over the last **420 years**
- **Severity: exponential curve calibrated with** 5 historical data points which are the **5 last pandemic events**

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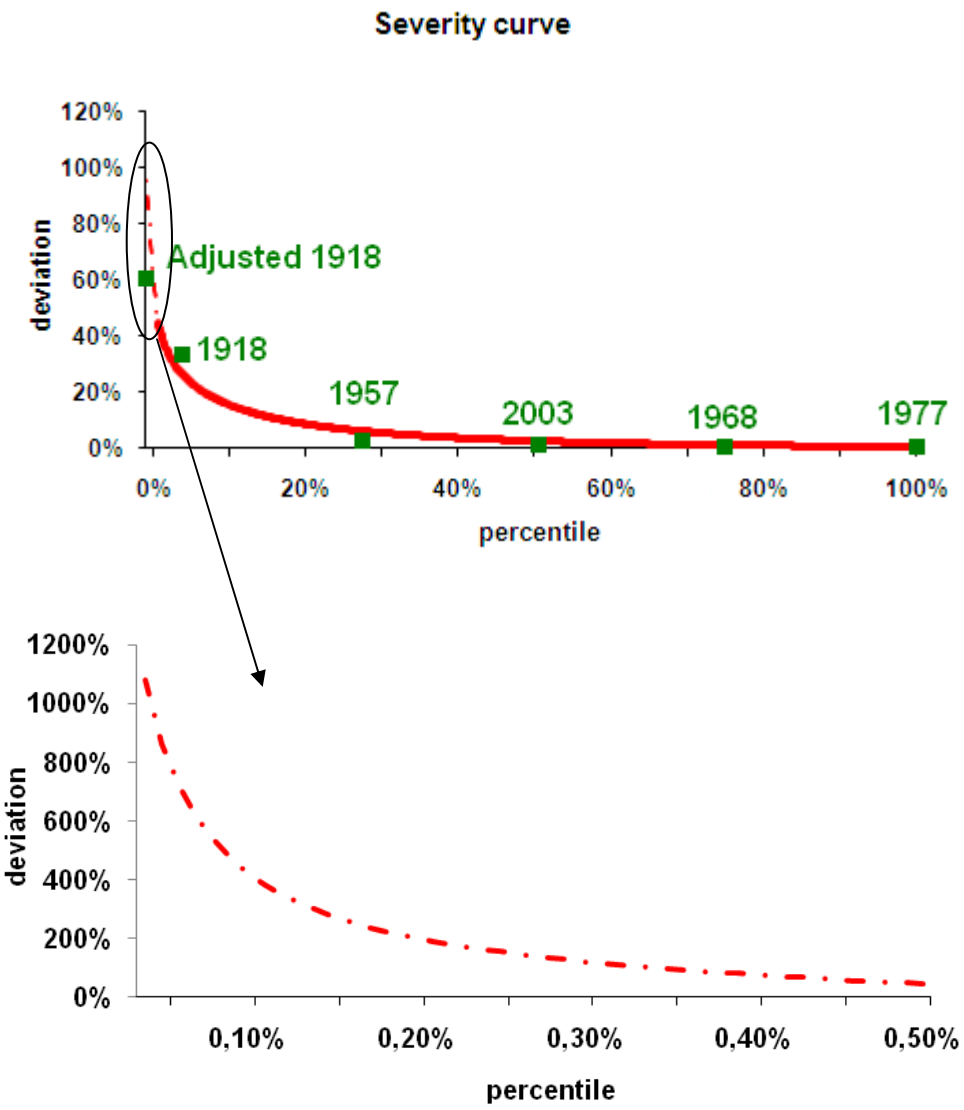
Pandemic Modeling



$$Severity = a \cdot \exp\left(-b \cdot \sqrt{r}\right)$$
$$si \quad r > 0{,}005$$

$$Severity = TAN(90 - c \cdot r) \cdot \frac{\pi}{180}$$
$$si \quad r \leq 0{,}005$$

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Pandemic Modeling

Paul Valéry

“What is simple is always wrong, what is complex is unusable.”

Limits

- pandemic risk is very uncertain and unpredictable
- many parameters not taken into account (like location of outbreak, vaccine production, pandemic lifecycle,…)

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EMB Pricing

Pricing a priori with Monte Carlo Simulations

$x = 1...X$ Simulation No $\quad t = 1...T$ time $\quad n = 1...N$ class No

$$R_{t,n} = \frac{I_t - A_n}{E_n - A_n} \qquad C_{t,n} = \begin{cases} R_{t,n} & si \quad t = 1 \\ Max\left(R_{t,n} - C_{t-1,n}\right) & si \quad t > 1 \end{cases}$$

$$PFL_n = \frac{\sum_x \delta_{\{C_{t,n}>0\}}}{X} \qquad \delta_{\{C_{t,n}>0\}} = \begin{cases} 1 & si \quad C_{t,n} > 0 \\ 0 & si \quad C_{t,n} = 0 \end{cases} \qquad PE_n = \frac{\sum_x \zeta_{\{C_{t,n}=1\}}}{X} \qquad \zeta_{\{C_{t,n}=1\}} = \begin{cases} 1 & si \quad C_{t,n} = 1 \\ 0 & si \quad C_{t,n} = 0 \end{cases} \qquad EL_n = \frac{\sum_x \sum_t C_{x,t,n}}{X}$$

Estimation for each class of Notes n :

EL_n the Expected Loss
PFL_n the Probability of First Loss
PE_n the Probability of Exhaustion

$$CEL_n = \frac{EL_n}{PFL_n}$$ the Conditional Expected Loss

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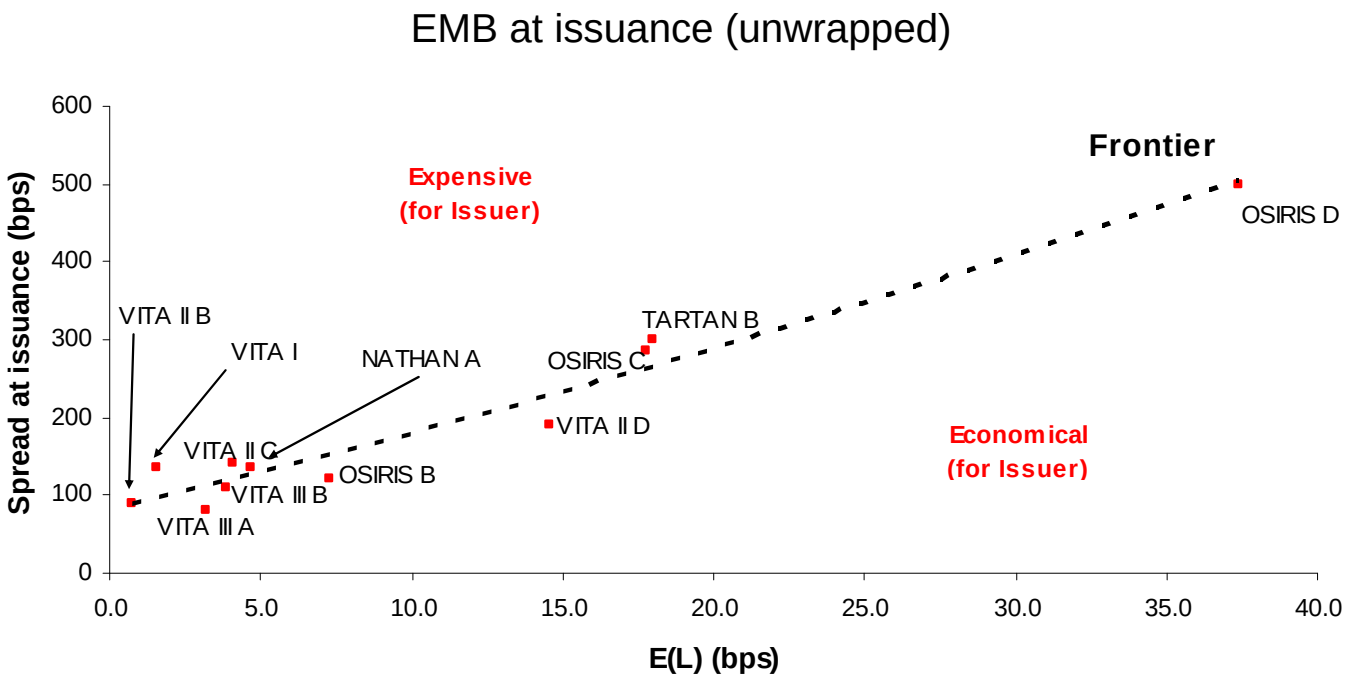
EMB Pricing

Spread and E(L) dependence measured a posteriori



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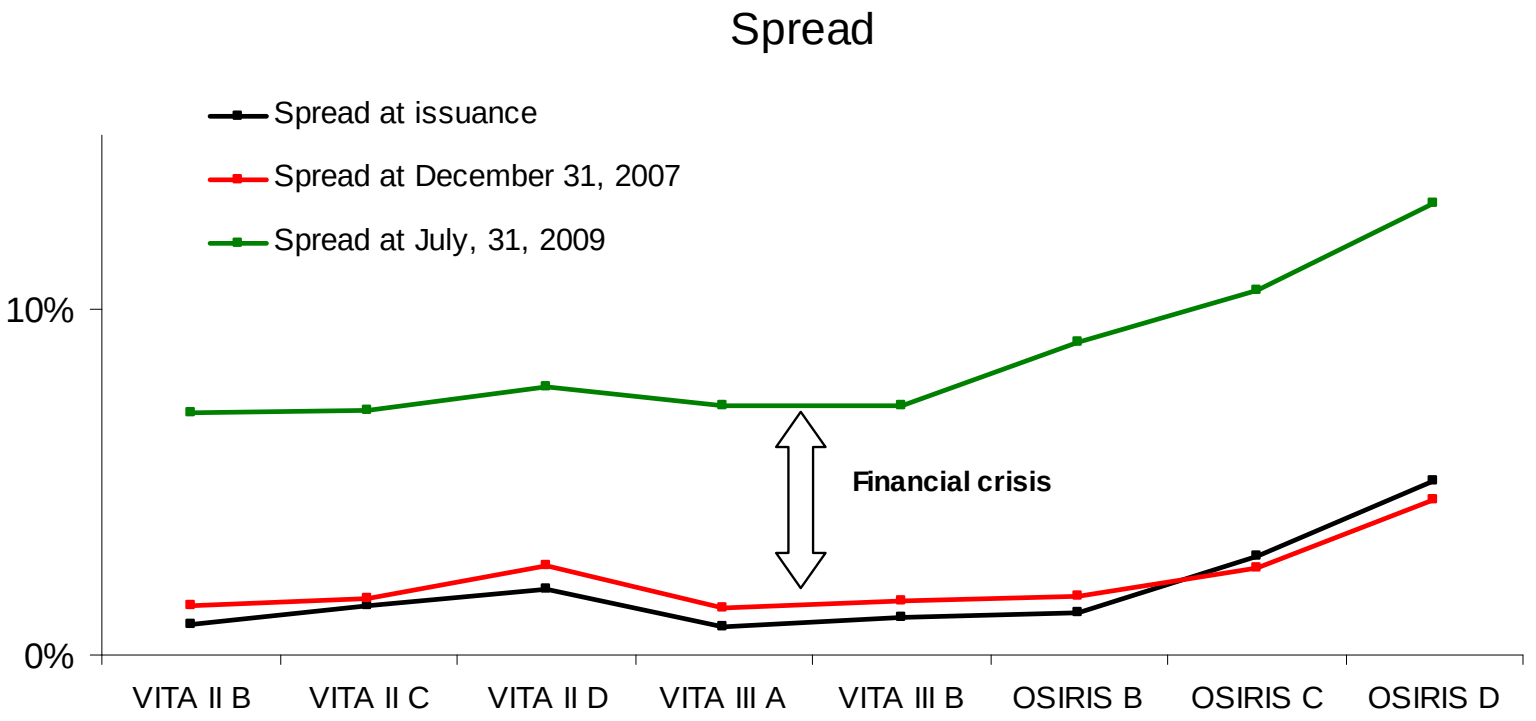
Spread Variations



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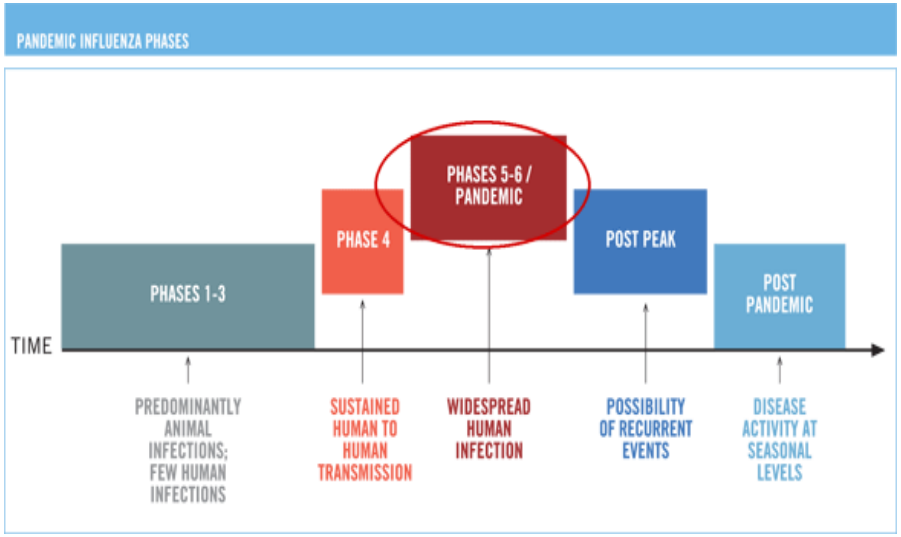

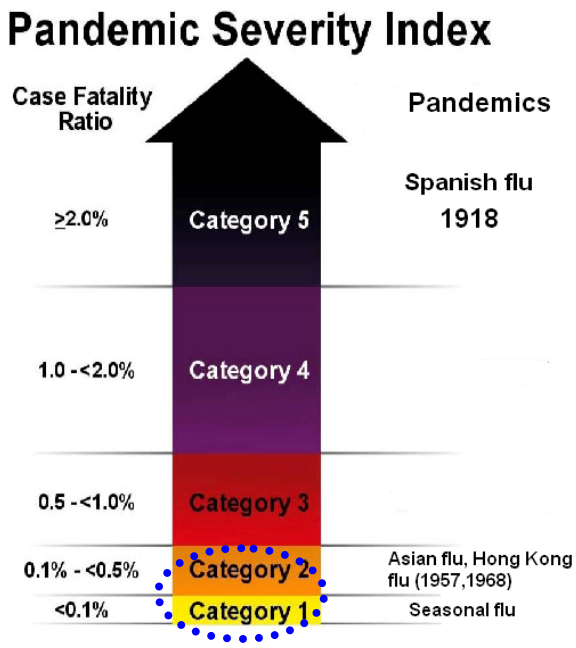

Low excess mortality but possible future evolution

- Mutation
- Drug Resistance

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Source: WHO, CDC

2009 influenza A/H1N1

Mortality Bond	OSIRIS		
Mortality Holder	Axa		
Issue date - Maturity	January 2006 - January 2010		
Index of Mortality	60% France, 25% Japan, 15% US Weighted by age and gender		
Class	B	C	D
Attachment Point	114%	110%	106%
Exhaustion Point	119%	114%	110%
Spread at issuance	120 bp	285 bp	500 bp
Rating at issuance (S&P)	A-	BBB	BB+

OSIRIS Index

Fatality rate / Infection rate	5%	10%	30%
0.05%	100%	101%	102%
0.10%	101%	101%	104%
0.50%	104%	107%	122%
1.00%	107%	115%	145%

Seasonal flu

Attachment reached

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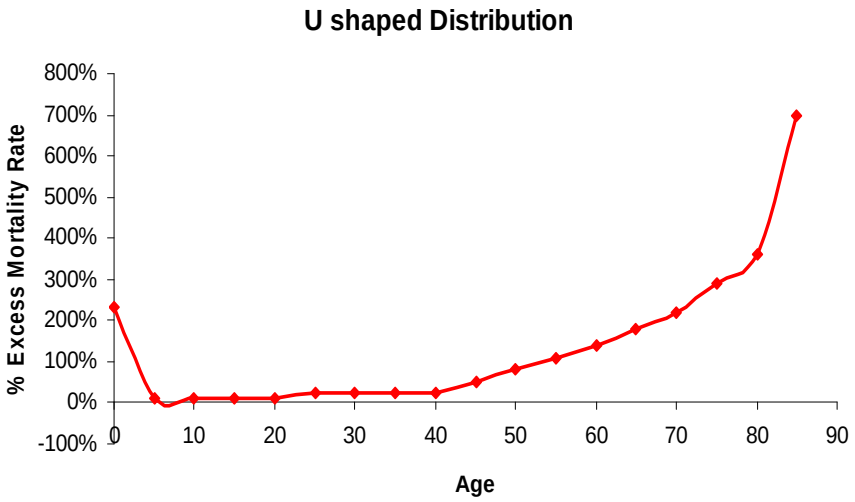
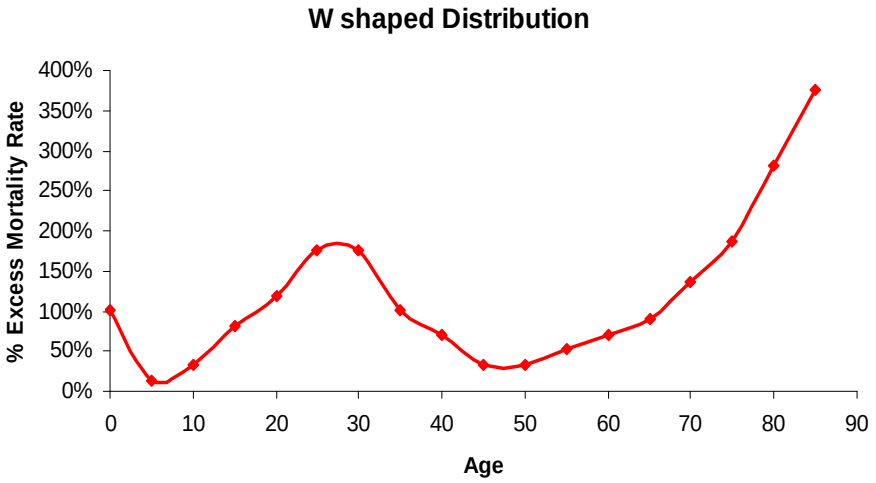
Pandemic Modeling

Age shape depending on Pandemic's virulence



Low virulence



High virulence

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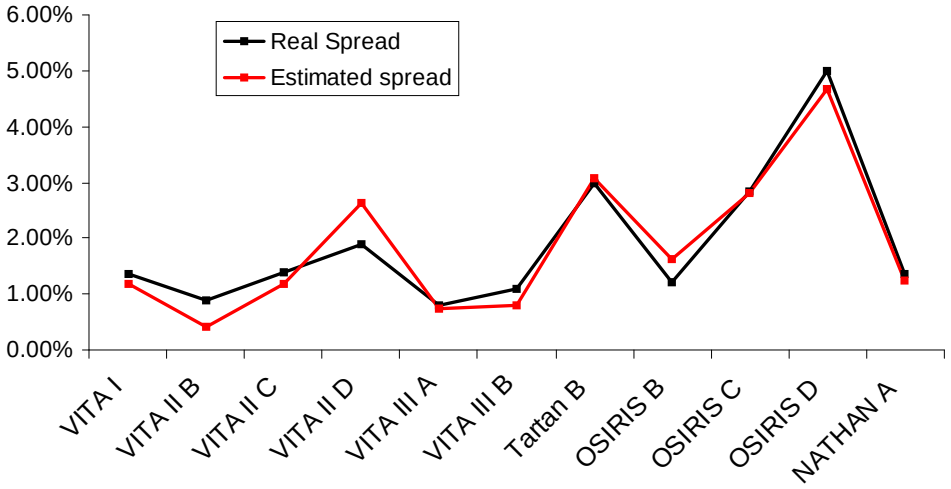
Spread at issuance & risk parameters

$$Spread = \overbrace{E(L)}^{Expected\ Loss} + \underbrace{EER}_{Expected\ Excess\ Return}$$

$$EER = \gamma (PFL)^{\alpha} . (CEL)^{\beta}$$

(NatCat Bonds Approach)



$\alpha = 0.68$

$\beta = 0$

$\gamma = 1.5$

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